

We have also attempted to study the dependence of the photovoltaic effects of the Chl-*a* sandwich cells on the electrode materials⁸. A correlation between the photovoltaic activity and the work function of the metals is observed, which further indicates that the Schottky barrier is directly responsible for the photoactivity. For instance, in a (Cr|Chl-*a*|Ga) cell, where Ga has a lower work function than Cr, the dominant Schottky barrier is established at the back, Chl-*a*|Ga, contact. The observed photovoltaic activity is dramatically different. The sign of the i_{sc} is now in a direction opposite to that seen in the (Cr|Chl-*a*|Hg) cell. Furthermore, the i_{sc} spectral response shows maxima in the spectral regions where the Chl-*a* film only absorbs slightly, that is, an "inner filter" effect is observed.

Table 1 Photovoltaic characteristics of ten (Cr|Chl-*a*|Hg) cells

Cell	V_{oc} (V)	i_{sc} (in 10^{-8} A)	P_{max} (in 10^{-8} W)	P_{max}/P_{in} (in $10^{-2}\%$)
1	0.32	8.0	1.00	1.6
2	0.31	6.0	1.08	1.0
3	0.18	3.9	0.43	0.43
4	0.19	7.3	0.47	0.68
5	0.18	5.0	0.30	0.50
6	0.21	5.0	0.38	0.63
7	0.18	8.0	0.48	0.80
8	0.30	7.5	0.80	1.40
9	0.20	6.0	0.50	0.83
10	0.25	2.5	0.40	0.67

V_{oc} is the open circuit voltage, i_{sc} is the short circuit current at the 745 nm light intensity of 7.6×10^{-4} W cm⁻². P_{in} is the incident radiative power on the cell (no correction is made for the power absorbed by the Cr). P_{max}/P_{in} is the photovoltaic power conversion ratio.

The Schottky barrier model for the system predicts an activation energy for a forward bias current which consists of a voltage dependent term, $-eV/n$, and the barrier height (contained exponentially in i_0) at the Cr|Chl-*a* contact⁸. Accordingly, after correcting the observed activation energy for the forward bias voltage, barrier heights on the order of 0.4–0.7 eV are obtained, depending on the sample. Measurements of activation energies on a single sample at different bias voltages, or with cells having different electrode materials should test further the contact barrier model for the Chl-*a* system. The activation energy seen for the photovoltaic current seems to be exceptionally low for organic systems. Evidently, the steps leading to charge generation and transport following light absorption by Chl-*a* involve at most very weakly activated processes.

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C. W. TANG
A. C. ALBRECHT

Department of Chemistry,
Cornell University,
Ithaca, New York 14850

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Can linguistic competence be dissociated from natural language functions?

THE preservation of non-verbal intellectual functions in spite of severe disruption of natural language has been well documented by studies of aphasia¹. But are the cognitive functions specific to normal verbal communication also preserved in the absence of language? In addition to its theoretical significance, this question has practical importance with respect to both infra-human primates and severe aphasics². These groups cannot use natural language because of the destruction or apparent absence of crucial cortical zones of the brain and effective communication may depend on their mastering an alternative symbol system which captures relevant cognitive properties of natural language. A crucial test of the hypothesised dissociation between natural language and its cognitive prerequisites is whether aphasic subjects can use arbitrarily designed symbols to represent elements of experience (events, properties, actions and so on); encode meaningful relationships in terms of the configurational properties, or syntax, of the symbol sequence; and have the capacity to encode such relationships in alternative syntactic forms^{3,4}.

We have verified the preservation of these cognitive concomitants of natural language in a severely aphasic patient. W.S. is a 21-yr-old right-handed male who was evaluated for language after surgical removal of a large, acute subdural haematoma of the left temporo-parietal lobe following severe head trauma. Ten weeks after surgery, at the time of admission to our unit, he had mild weakness in his right seventh cranial nerve and probable loss of smell sensation on the left; the remainder of his neurological and physical examination was normal. At this time he was observed to have very poor comprehension of spoken and written language. His speech was markedly paraphasic and devoid of information. On the Boston Diagnostic Aphasia Examination⁵, he scored near zero on subtests of auditory comprehension, naming, reading comprehension and writing. But he seemed to be extremely well oriented and alert, and when his intelligence was tested he executed the block design, picture arrangements and object assembly subtests of the Wechsler Adult Intelligence Scale at a superior level (scale scores of 12).

W.S. entered our research-therapy programme called VIC (Visual Communication) in which messages are formed by laying out—from left to right—index cards on which arbitrary or ideographic symbols stand for nouns and verbs, grammatical morphemes, sentence modality and tense markers, and meta-linguistic signals. The patient observes VIC communicators 'converse' with one another and then is gradually drawn into the conversation himself. Within two 30-min sessions W.S. had mastered the basics of the system; he demonstrated knowledge of the meaning of VIC symbols and the rules of the syntax governing VIC communication. Specifically, he could follow commands, answer simple questions, and describe events, with the total number of possible transactions running into the hundreds. After 14 additional 30-min sessions of VIC, W.S. could transmit and receive information involving direct and indirect objects, antonymic contrasts of verbs and of prepositions, judgments on the truth value of statements, and shifts in sentence modality, for example, from the interrogative to the declarative. More practically, W.S. was able to use the cards to express certain feelings and ideas; clearly VIC served as an alternative for his vitiated natural language capacity.

Here is a sample annotated exchange, translated into English. Word sequences designated by a single ideograph are connected by hyphens.

(1) Command involving a reordering of the element in the surface form of the utterance: Therapist (T): ! W.S. please-put spoon or fork to-the-right-of-the pencil. W.S. executes act with fork.

(2) Answering question requiring multiple specification of nouns and expansion of constituent: T gives pencil and razor to Y. T: ? Who give(s)-to what (to) whom. W.S.: T give(s)-to pencil and razor (to) Y.

(3) Appropriate response when confronted with a novel surface form: T picks up a cookie. T: ? What T pick-up [rather than normal form: ? T pick-up what]. W.S.: T pick(s) up cookie.

(4) Spontaneous utterance in VIC: T takes out pack of cigarettes. W.S.: W.S. want(s) cigarette (a few seconds elapse) and matches.

To establish that this success was not the result of a mapping of VIC on to residual or recovering natural language functions, W.S. was given an extensive test of spoken and written English, with all items equivalent to VIC messages. He performed without error on items in VIC, but scored only 12.5% correct in English.

The design of VIC suffices to demonstrate important conceptual operations entailed in ordinary language. First, W.S. seems to understand and use the symbols in terms of the normal categories of perceptual experience (for example, actor- action- object and indirect object of the action). Second, W.S. seems to understand the meaning relations among the categories in terms of a small number of configurations and to deal appropriately with novel messages; both of these capacities suggest that he can understand VIC sequences in terms of the relations among the component elements. Third, W.S. is not bound by referentially constrained situations in his use of VIC. Finally, W.S. seems to exhibit the beginnings of productive use of VIC, by virtue of his ability to expand on constituents that request information.

The case of W.S. shows that certain cognitive capacities entailed in natural language can be preserved in its absence. This patient was unique among VIC communicators in the speed and facility with which he mastered the system. The fact that five out of eight patients tested have mastered the basic components of the system within 6 weeks, however, and have performed at a level superior to their performance with English, indicates at least some dissociation among the two functions in severely aphasic patients.

The performance of W.S. can be compared usefully with those of Sarah⁶, Washoe⁷ and Lana⁸, primates used in communication studies; however, his achievement differs not only in its overall level of proficiency, but also in the apparent fact that Sarah has not used her symbol system for spontaneous communication while Washoe has not used syntax consistently. The skill of W.S. at mapping his knowledge of the environment on to a symbol system without the apparent aid of a mediating system is most reminiscent of that found in young children, and, perhaps, in Lana. Possibly our patient is in the paradoxical position of retaining cortical capacity for communication using symbols while having lost, at least temporarily, the ability to handle natural language.

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ERROL BAKER
THOMASIN BERRY
HOWARD GARDNER
EDGAR ZURIF
LYNN DAVIS
AMY VEROFF

*Aphasia Research Center,
Boston University School of Medicine and
Psychology Service,
Boston Veterans Administration Hospital,
Boston, Massachusetts 02130*

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Intensification of the alcohol withdrawal syndrome by repeated brain stimulation

SINCE the discovery that electrical stimulation of discrete sites of the brain can influence behaviour, there have been numerous reports of its application¹. Such procedures, however, may lead to kindling²; stimulation of some sites at currents initially too low to produce a behavioural response may lead to a gradual development and then intensification of seizures evoked by the stimulation³. Thus when the brain is repeatedly stimulated for therapeutic purposes, seizures may be elicited unless procedures not conducive to kindling are used². Two questions arise: can kindling leave an organism more susceptible to seizures produced by agents other than local brain stimulation, and are elicited convulsions necessary for this change in susceptibility? Our findings indicate that whether or not overt convulsions are produced by brain stimulation, repeated electrical stimulation of the brain potentiates the effects of subsequent alcohol withdrawal.

To answer the first question we studied the interaction of kindling and alcohol. When large quantities of ethanol have been metabolised an organism is in a state of heightened seizure susceptibility⁴. In alcoholics this withdrawal syndrome is often characterised by tremors and other mild epileptic symptoms, and *grand mal* convulsions and death can ensue. Even in organisms that display no obvious symptoms, there is an increased susceptibility to seizures induced by other agents after withdrawal⁴. Hence, if kindling affects general seizure susceptibility, this should be reflected in an intensification of the alcohol withdrawal syndrome.

Twenty-seven, male, black-hooded rats (Canadian Breeding Farms, La Prairie, Quebec) were implanted with unilateral, bipolar electrodes aimed at the centre of the amygdaloid complex. After 1 week of recovery, 12 randomly selected rats were kindled with 45 brain stimulations (1 s, 400 μ A, 60 Hz) administered three times per day, 5 d per week. The animals were kindled successfully in that each eventually displayed at least one bilateral seizure involving clonic activity of the head, mouth and fore-limbs accompanied by rearing and loss of equilibrium. The remaining implanted animals served as unstimulated controls.

Three days after the last stimulation, rats in both groups received 45 intubations of a 20% volumetrically prepared alcohol solution (1,000 mg kg⁻¹) as before⁵. Intubations were at 8-h intervals and intoxication was tested 1 h after each intubation. An animal was considered intoxicated when it exhibited two or more of the following symptoms: (1) unconsciousness before handling, (2) inability to manoeuvre on a vertical screen or (3) ataxia. If there were no signs of intoxication, subsequent doses were increased by 200 mg kg⁻¹ until intoxication was produced. All animals developed a tolerance to the alcohol; the mean difference between the first and last intoxicating dose was 870 mg kg⁻¹ and every animal showed an increase of at least 200 mg kg⁻¹ ($\chi^2 = 20.02$; $P < 0.001$). Before withdrawal the body weights (mean = 342 g) and effective intoxicating doses (mean = 2,018 mg kg⁻¹) were similar for stimulated and unstimulated animals.

Commencing 9 h after the last intubation each animal was placed under formal observation for 2 min every 3 h by an experimenter, unaware of the animal's experimental history, who recorded the presence or absence of the following seven withdrawal symptoms: rhythmic activity of the mouth, facial tremors, rhythmic eye or ear twitching, myoclonic body jerks, tail tonus, rhythmic head nodding and hyperreactivity to handling. Since there were six observation sessions, the maxi-